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Motor and Apparatus Using the Same Motor

Field of the Invention

The present invention relates to a motor to be used for recording and/or reproducing information stored in a compact disc or a video disc, and an apparatus using the same motor. More particularly, it relates to a motor structure which can improve oil-holding performance of oil-impregnated metal, and a motor structure which can restrain a rotor from moving and vibrating axially due to axial attraction from an attracting magnet.

Background of the Invention

Recently, oil-impregnated metal made of porous metal has been widely used for a bearing in order to meet a requirement of lowering the cost of motors that drive optical discs or optical-magneto discs for recording and/or reproducing information stored therein. However, an apparatus such as a compact-disc player or a videodisc player runs at a higher speed than ever, and this trend reduces a long-term reliability of the bearing, and thus the motors encounter the following problems:

necessity of an oil-holding structure of the oil-impregnated metal which forms the bearing; and

measures against oil splashed from the oil-impregnated metal.

If a rotor moves or vibrates axially when the motor is driven at a high speed, errors could occur in reading/writing information from/to a disc.

A conventional motor is disclosed in Japanese Published Unexamined Patent Application No. H08-289523. Fig. 9 shows a construction of the conventional motor. In Fig. 9, shaft 101 transmits rotation. Ring-shaped

rotor-magnet 103 is press-fitted or rigidly bonded to an inner wall of frame 102. Magnet 103 is multipolar magnetized in a circumferential direction. Burring process is applied to the center of frame 102, and shaft 101 is directly press-fitted into the burring-processed section. Rotor 111 comprises shaft 101, frame 102 and magnet 103.

Bracket 104 made of magnetic material is formed by press working, and has burring-processed section 112 that projects like steps at an approx. center. Burring-processed section 112 works as bearing housing 123 accommodating a bearing. Bracket 104 includes burring-processed section 112 with which mounting-base 113 is unitarily formed. Base 113 is used for mounting a motor to an apparatus.

On an inner wall of burring-processed section 112, oil-impregnated metal 105 is press-fitted for supporting shaft 101 rotatably. On the other hand, on an outer wall of section 112, stator core 114 is press-fitted. On core 114, copper wire 106 is wound via an insulator made of resin.

Printed circuit board 107, which includes at least a part of circuits driving and controlling the motor, is rigidly bonded to base 113 with double-faced adhesive tape (not shown). An end of copper wire 106 is connected onto board 107.

Stopper 108 — preventing rotor 111 from coming off in a thrust direction — is formed by metal pressing work. Stopper 108 is press-fitted to an end of shaft 101. Bottom plate 109 bears load of rotor 111 in the thrust direction via resin board 110 of abrasion resistance. Bottom plate 109 is press-fitted into the inner wall of burring-processed section 112.

A plurality of through-holes 116 are punched on a top plate of frame 102. When bottom plate 109 is press-fitted into section 112, face "P" of stator core 114 can be supported with a jig (not shown) extending through holes 116, so that the

force caused by press-fitting is restrained from being applied to base 113.

However, the structure discussed above allows oil leaked from the top of oil-impregnated metal 105 to splash outward during the rotation of rotor 111. The oil splashed moves to stator core 114, travels on the inner wall of frame 102 and arrives at magnet 103. As a result, the oil impregnated in metal 105 decreases, which lowers the reliability of the bearing spinning at a high speed. Thus the motor cannot suit for an apparatus demanded to spin at a higher speed.

In the conventional motor discussed above, attraction force (called magnetic thrust) working axially between stator 115 and rotor 111 is produced by the deviation between the center of an axial length of stator core 114 and the center of an axial length of rotor magnet 103. In other words, the attraction force can be produced by shifting magnetic center H1 appropriately. This attraction force working between stator 115 and rotor 111 allows a disc to vibrate smaller in the axial direction, thereby preventing read/write errors.

Another conventional motor — having a different structure to produce attraction force — is disclosed in Japanese Published Unexamined Patent Application No. H11-55900. The motor disclosed in this application comprises the following elements:

a rotary shaft;

a bearing for journaling the rotary shaft;

a hub fixed to the rotary shaft;

a stopper, for preventing a motor from coming off, made of magnetic material and fixed to the hub;

an attracting magnet mounted to the stopper;

a bracket for holding the bearing; and

a coil assembly fixed to the bracket.

The attracting magnet faces a core of the coil assembly. The stopper slides with the bearing only when a rotating body moves. This structure prevents the motor from coming off, and restrains vibrations in both a radial and a thrust directions.

However, according to the publication discussed above, oil leaked from an oilless bearing cannot be collected or returned to the bearing per se, therefore, it is difficult to further improve the reliability of the motor spinning at a higher speed. Major magnetic field produced by a driving current running through the coil is affected by magnetic flux from the attracting magnet because the attracting magnet is disposed closely to the coil assembly, and the major magnetic field produces magnetic interference.

Still another conventional motor is disclosed in Japanese Published Unexamined Patent Application No. 2000-245116. This conventional motor comprises the following elements:

a stationary member;

a rotor rotatable with respect to the stationary member;

a bearing disposed between the stationary member and the rotor;

a rotor magnet mounted to the rotor; and

a stator mounted to the stationary member.

The rotor includes a cup-shaped rotor made of magnetic material. The cup-shaped rotor has an annular wall and an end wall disposed on a first end of the annular wall. The rotor magnet is formed of sheet-like rubber magnet. This rubber magnet is mounted forming a ring shape on an inner face of the annular wall. Magnetic energizing means, for energizing the rotor axially, is mounted to the stationary member, where the magnetic energizing means includes a sintered magnet of ferrite system and faces the end wall of the cup-shaped rotor. This structure allows the conventional motor to be manufactured at a lower cost

and obtain desirable energizing force.

However, this structure needs additionally a holder as an element of the magnetic energizing means, and yet, this structure cannot collect oil leaked from the oilless bearing or return the oil to the bearing per se. Therefore, it is difficult for this structure to further improve the reliability of the bearing spinning at a higher speed. Furthermore since the energizing means is placed above the stator core, this structure is not suited for a motor used in a slim apparatus.

Summary of the Invention

The present invention addresses the problems discussed above, and aims to provide a motor suitable for a disc driving apparatus which records and/or reproduces information stored in a compact disc, videodisc, optical disc, optical magneto disc or the like, and an apparatus using the same motor.

To be more specific, the present invention aims to provide a motor structure that meets a requirement of downsizing and lowering of profile of an apparatus as well as improves the reliability of a motor-bearing spinning at a higher speed. At the same time, the present invention aims to provide a motor in a simple construction which prevents a disc from moving or vibrating in an axial direction in order to reduce read/write errors, and an apparatus using the same motor.

The motor of the present invention comprises the following elements:

(a) a bracket incorporating a bearing housing, and a mounting base for mounting a motor to an apparatus;

(b) oil-impregnated metal fixed to an inner wall of the bearing housing;

(c) a stator in which a stator core wound with coils is disposed on an outer wall of the bearing housing;

(d) a rotor including a frame having a plurality of through holes on a top surface of the frame, a shaft fixed to the frame, and a rotor magnet fixed to the frame; and

(e) a cap facing the through holes and disposed at a place spaced from the through holes.

The apparatus of the present invention includes a housing and the motor discussed above and mounted in the housing via the mounting base.

The motor structure discussed above allows the stator to be supported with, e.g., supporting-pins through the through holes because the cap is positioned at a place corresponding to the through holes punched on the frame. Force generated in assembling the motor is thus not applied to the mounting base, so that the assembly does not impair precision of the mounting base. Further, the cap can prevent oil from splashing.

Brief Description of the Drawings

Fig. 1A shows a structure of a motor in accordance with a first exemplary embodiment of the present invention.

Fig. 1B is a top view of a rotor of the motor shown in Fig. 1A.

Fig. 2 illustrates how a bottom plate of the motor shown in Fig. 1A is press-fitted.

Fig. 3A shows a structure of a motor in accordance with a second exemplary embodiment of the present invention.

Fig. 3B is a top view of a rotor of the motor shown in Fig. 3A.

Fig. 4 illustrates how a bottom plate of the motor shown in Fig. 3A is press-fitted.

Fig. 5A shows a structure of a motor in accordance with a third exemplary embodiment of the present invention.

Fig. 5B illustrates a magnetized status of an attracting magnet in the motor shown in Fig. 5A.

Fig. 6 illustrates how a bottom plate of the motor shown in Fig. 5A is press-fitted.

Fig. 7 shows a figure of an apparatus in accordance with a fourth exemplary embodiment of the present invention.

Fig. 8 shows a schematic structure of the apparatus shown in Fig. 7, where the apparatus employs the motor in accordance with the first exemplary embodiment.

Fig. 9 shows a structure of a conventional motor.

Detailed Description of Preferred Embodiments

Exemplary embodiments of the present invention are demonstrated hereinafter with reference to the accompanying drawings.

First Exemplary Embodiment

Fig. 1A shows a structure of a motor in accordance with the first exemplary embodiment of the present invention. Fig. 1B is a top view of a rotor of the motor shown in Fig. 1A. Fig. 2 illustrates how a bottom plate of the motor shown in Fig. 1A is press-fitted.

In Fig. 1A and Fig. 1B, shaft 1 outputs power of the motor, for instance, it transmits rotation to a disc. Ring-shaped rotor-magnet 3 is press-fitted or rigidly bonded to an inner wall of frame 2. Magnet 3 is multipolar magnetized in a circumferential direction. Burring process is applied to the center of frame 2, and shaft 1 is directly press-fitted into a first burring-processed section. Rotor 11 comprises shaft 1, frame 2 and magnet 3.

Bracket 4 made of magnetic material is formed by press working, and has second burring-processed section 12 that projects like steps at an approx. center.

Burring-processed section 12 works as bearing housing 23 accommodating a bearing. Bracket 4 includes burring-processed section 12 with which mounting-base 13 is unitarily formed. Base 13 is used for mounting the motor to an apparatus. This unitary formation improves accuracy of right angles of mounting base 13 with respect to burring-processed section 12.

On an inner wall of burring-processed section 12, oil-impregnated metal 5 is press-fitted for supporting shaft 1 rotatably. On the other hand, on an outer wall of section 12, stator core 14 is press-fitted. On core 14, copper wire 6 is wound via an insulator made of resin.

Printed circuit board 7, which contains at least a part of circuits driving and controlling the motor, is rigidly bonded to base 13 with double-faced adhesive tape (not shown). An end of copper wire 6 is connected onto board 7. Stator 15 comprises bracket 4, oil-impregnated metal 5, copper wire 6, board 7 and stator core 14.

Four through-holes 16 (at least two holes) are punched on a top surface of frame 2. Cap 17 is placed at a place spaced from the through holes 16 axially. To be more specific, a first end of cap 17 faces through holes 16, and cap 17 is press-fitted from its second end into an inner wall of stator core 14 so that cap 17 has clearance from the top plate of frame 2 in an axial direction.

Stopper 8 prevents rotor 11 from coming off in the thrust direction and is formed by metal-pressing work. Stopper 8 is press-fitted to an end of shaft 1. Bottom plate 9 bears load of rotor 11 in the thrust direction via resin board 10 of abrasion resistance. Bottom plate 9 is press-fitted into the inner wall of burring-processed section 12.

A sectional form of cap 17 is described hereinafter. An end face on the side of first end 19, which is not press-fitted to stator core 14, of cap 17 has a smaller inner diameter than that of another section 20 of cap 17, where section

20 is press-fitted. This formation prevents oil from splashing outside cylinder section 21 of cap 17 even if the oil leaks from the top of oil-impregnated metal during the rotation, because cylinder section 21 of cap 17 works as a barrier against the oil splashing.

A radial gap is provided between the outer wall of metal 5 and the inner wall of cylinder section 21. The oil splashing to cylinder section 21 enters into the radial gap, and returns to oil-impregnated metal 5. This radial gap can thus recycle the oil. The structure discussed above improves oil-holding performance of metal 5, and collects the splashed oil and returns it to oil-impregnated metal 5 per se.

A process of press-fitting the bottom plate of the motor shown in Fig. 1A is demonstrated with reference to Fig. 2. As discussed above, a plurality of through-holes are punched on frame 2 of rotor 11. When bottom plate 9 is press-fitted to burring-processed section 12 of bracket 4, supporting pins 22 support the end face of cap 17 through through-holes 16. Force produced in press-fitting is thus not applied to mounting base 13 of bracket 4 when the motor is assembled.

Bottom plate 9 can be press-fitted while mounting base 13 is held at accurate right angles with respect to burring-processed section 12 of bracket 4. Mounting base 13, oil-impregnated metal 5 press-fitted to base 13, and shaft 1 journaled by metal 5 can be thus assembled at accurate right angles with respect to burring-processed section 12.

Second Exemplary Embodiment

Fig. 3A shows a structure of a motor in accordance with the second exemplary embodiment of the present invention. Fig. 3B is a top view of a rotor of the motor shown in Fig. 3A. Fig. 4 illustrates how a bottom plate of the

motor shown in Fig. 3A is press-fitted.

The second embodiment differs from the first one in the following points: Cap 17 in accordance with the second embodiment is made of magnetic material, and attracting magnet 18 is placed on a top surface of stator core 14 which is disposed outside of cap 17. Magnet 18 is made of material having excellent magnetic characteristics such as sintered magnet of Neodymium-Iron-Boron (Nd-Fe-B) system. In the second embodiment, elements similar to those in the first embodiment have the same reference marks.

Press-fitting the bottom plate of the motor shown in Fig. 3A is demonstrated with reference to Fig. 4. A plurality of through-holes 16 are punched on a top surface of frame 2 of rotor 11. When bottom plate 9 is press-fitted into bracket 4, supporting pins 22 support an end face of cap 17 through through-holes 16. The force produced in press-fitting bottom plate 9 is thus not applied to mounting base 13 of bracket 4 during the assembly of the motor.

Bottom plate 9 is therefore press-fitted into bracket 4 while the right angles of base 13 with respect to burring-processed section 12 of bracket 4 are accurately maintained. Mounting base 13, oil-impregnated metal 5 press-fitted to base 13, and shaft 1 journaled by metal 5 can be thus assembled at accurate right angles with respect to burring-processed section 12.

In this second embodiment, a height of an end face of cap 17 on the side of first end 19 is greater than that of an end face of attracting magnet 18. Supporting pins 22 thus positively support the end face of cap 17 on the side of first end 19 of shaft 1, and when bottom plate 9 is press-fitted, the force is borne by supporting pins 22 via cap 17. This structure prevents the force from being applied to attracting magnet 18. As a result, attracting magnet 18 is kept free from damages.

Almost all the magnetic flux from magnet 18 runs through stator core 14

and travels to frame 2 via cap 17 made of magnetic material, and forms a magnetic path returning to magnet 18 from the top surface of frame 2. The magnetic flux thus does not cross link with magnetic flux from the coil formed of copper wire 6 of stator 15 or magnetic flux from rotor magnet 3. As a result, magnetic circuits of stator 15 and magnet 3 are free from magnetic interference from attracting magnet 18, and do not adversely affect rotor 11 to spin.

Magnet 18 is desirably magnetized unipolar thicknesswise such as N pole on the top surface and S pole on the bottom surface or vice versa, or it is desirably magnetized bipolar on planes in parallel such as N-S on the top surface and S-N on the bottom surface.

In the second embodiment, as same as the first one, an end face on the side of first end 19, which is not press-fitted to stator core 14, of cap 17 has a smaller inner diameter than that of another section 20 of cap 17, where section 20 is press-fitted. This formation prevents oil from splashing outside cylinder section 21 even if the oil leaks from the top of oil-impregnated metal during the rotation, because cylinder section 21 of cap 17 works as a barrier against oil splashing.

A radial gap is provided between the outer wall of metal 5 and the inner wall of cylinder section 21. The oil splashing to cylinder section 21 enters into the radial gap, and returns to oil-impregnated metal 5. This radial gap can thus recycle the oil. The structure discussed above improves oil-holding performance of metal 5, and collects the splashed oil and returns it to oil-impregnated metal 5 per se.

Further in this second embodiment, magnetic attracting force works between attracting magnet 18 and the top surface of frame 2. Therefore, magnetic energizing force (attracting force) works axially to rotor 11 to be attracted toward stator 15. This structure saves a need to deviate the center of

axial length of stator core 14 from the center of axial length of rotor magnet 3, i.e., a need to deviate the magnetic centers thereof. Therefore, the motor can be assembled with ease, and magnetic noises due to a deviation between the magnetic centers can be reduced.

Third Exemplary Embodiment

Fig. 5A shows a structure of a motor in accordance with the third exemplary embodiment of the present invention. Fig. 5B illustrates a magnetized status of an attracting magnet in the motor shown in Fig. 5A. Fig. 6 illustrates how a bottom plate of the motor shown in Fig. 5A is press-fitted.

In Fig. 5A and Fig. 5B, shaft 1 transmits the rotation. Ring-shaped rotor magnet 3, which is multipolar magnetized in a circumferential direction, is press-fitted or bonded to an inner wall of frame 2. On a top face of frame 2, a plurality of through-holes 16 are punched. Burring-process is provided to a center section of frame 2, and shaft 1 is directly press-fitted into the burring-processed section. Rotor 11 thus comprises shaft 1, frame 2 and magnet 3.

Bracket 4 is made of magnetic material and formed by press working. Bracket 4 is unitarily formed with mounting base 13 which is used for mounting the motor to an apparatus. Further, bearing housing 23 is mounted to bracket 4 by caulking or the like.

Oil-impregnated metal 5 is accommodated inside of bearing housing 23, however; oil-impregnated metal 5 can be unitarily formed with bearing housing 23 instead of being accommodated therein. As shown in Fig. 5A, metal 5 can be also formed of two parts axially separated. Stator core 14 is press fitted outside bearing housing 23. Copper wire 6 is wound on stator core 14 via an insulator made of resin.

Printed circuit board 7, to which at least a part of circuits for controlling and driving the motor is mounted, is rigidly bonded to mounting base 13 with double-faced adhesive tape (not shown). An end of copper wire 6 is connected onto board 7. Stator 15 thus comprises bracket4, oil-impregnated metal 5, copper wire 6 and stator core 14.

Attracting magnet 18 is mounted on an upper face of stator core 14, where the upper face is opposite to through-holes 16 punched on a top surface of frame 2. Magnet 18 is made of material having excellent magnetic characteristics such as sintered magnet of Neodymium-Iron-Boron (Nd-Fe-B) system. Magnetic attracting force works between attracting magnet 18 and the top surface of frame 2. Therefore, magnetic energizing force (attracting force) works axially to rotor 11 to be attracted toward stator 15. This structure saves a need to deviate the center of axial length of stator core 14 from the center of axial length of rotor magnet 3, i.e., a need to deviate the magnetic centers thereof. Therefore, the motor can be assembled with ease, and magnetic noises due to a slide between the magnetic centers can be reduced.

Stopper 8—preventing rotor 11 from coming off in a thrust direction—is formed by metal press-working, and press-fitted to an end of shaft 1. Bottom plate 9 bears load of rotor 11 in a thrust direction via resin board 10 of abrasion resistance, and is fixed to a bottom section of bearing housing 23 by caulking. A plurality of through-holes 16 are punched on the top surface of frame 2, and when bottom plate 9 is caulked with housing 23, an end face of magnet 18 can be supported by supporting pins 22 through through-holes 16. The caulking force is thus not applied to mounting base 13 of bracket 4.

As a result, the right angles of bearing housing 23 with respect to mounting base 13 are accurately maintained. Mounting base 13, oil-impregnated metal 5 press-fitted to base 13, and shaft 1 journaled by metal 5

can be thus assembled maintaining accurate right angles.

With regard to fixing bottom plate 9 to bearing housing 23, housing 23 can be caulked with light load if housing 23 is made of easily extendable copper alloy. Therefore, when plate 9 is caulked and fixed to housing 23 while magnet 18 is supported by pins 22, magnet 18 made of sintered magnet of Nd-Fe-B system is free from being damaged because the caulking needs light load.

Attracting magnet 18 is preferably magnetized bipolar on planes in parallel as shown in Fig. 5B. When a plane is magnetized bipolar or multi-polar, magnetic flux generated from N pole of magnet 18 forms a magnetic path running to frame 2 opposite to magnet 18 and returning to S pole of magnet 18. Further, the magnetic flux from magnet 18 utilizes stator core 14 as a part of the magnetic path, where magnet 18 per se is mounted to stator core 14. Almost all of the magnetic flux from magnet 18 and the magnetic flux from coils of stator 6 or that of rotor magnet 3 thus do not cross link each other. Magnetic circuits of stator 15 and magnet 3 are not subjected to magnetic interference from attracting magnet 18, so that rotor 11 can spin free from being adversely affected.

At an end of shaft 1, frame 2 made of pressed-member is mounted. On a plane of outer circumference of frame 2, turntable cushion 24 for receiving a disc (not shown) is pasted. Disc-holding ring 25—shaping in approx. cylinder—for holding an internal circle section of the disc is press-fitted or rigidly bonded to frame 2. Ring 25 can position the disc in a radial direction, and the disc is spun with turntable cushion 24 pressed thereto, therefore, disc-holding ring 25 has holes therein for accommodating disc-clamping-claws 26. Spring 27 urges disc-clamping-claws 26 in the radial direction. The disc is urged to turntable cushion 24 by disc-clamping-claws 26. This structure allows the disc to spin at a high speed without floating off from frame 2, and information can be read or

written from/to the disc.

Fourth Exemplary Embodiment

Fig. 7 shows an outward appearance of an apparatus in accordance with the fourth exemplary embodiment of the present invention. Fig. 8 shows a schematic structure of the apparatus shown in Fig. 7, where the apparatus employs the motor in accordance with the first exemplary embodiment.

Apparatus 51 shown in Fig. 7 is specifically a compact-disc driving apparatus including housing 53. In Fig. 8, the motor in accordance with the first embodiment is mounted within housing 53 of apparatus 51. Mounting base 13 of motor bracket 4 is fixed to a mounting section 55 of the apparatus with screws 59.

The apparatus in accordance with the fourth embodiment can enjoy the same advantages as the motor in the first embodiment. The motor to be mounted to the apparatus of the present invention can be in accordance with not only the first embodiment but also the second or third embodiment. The apparatus of the present invention can expect the same advantages of the respective motors in accordance with each of the embodiments.

As discussed above, in a motor mainly used for reading or writing information from/to a disc such as a compact disc or a video disc, a cap is disposed above and outside an oil-impregnated metal. This structure allows the oil-impregnated metal to improve its oil-holding performance as well as collects and returns splashed oil to the oil-impregnated metal per se. Therefore, even if the oil leaked from the oil-impregnated metal splashes outward due to spin of the rotor, the oil splashed can be recycled to the metal per se, so that the bearing does not lower its reliability when the motor is spun at a high speed.

As a result, the present invention can provide a motor well suited for an apparatus running at a high speed as well as an apparatus using the same motor.

Magnetic attracting force works between an attracting magnet and a top surface of a motor frame. Therefore, magnetic energizing force (attracting force) works axially to a rotor to be attracted toward a stator, so that the rotor is restrained from moving and vibrating axially when the motor spins at a high speed. As a result, read/write errors can be reduced.

The cap is, in particular, made of magnetic material, and almost all of the magnetic flux from the attracting magnet travels along a path running through a top surface of the frame and the cap and returning to the attracting magnet. The magnetic flux from the attracting magnet does not adversely affect magnetic circuits of a rotor magnet.